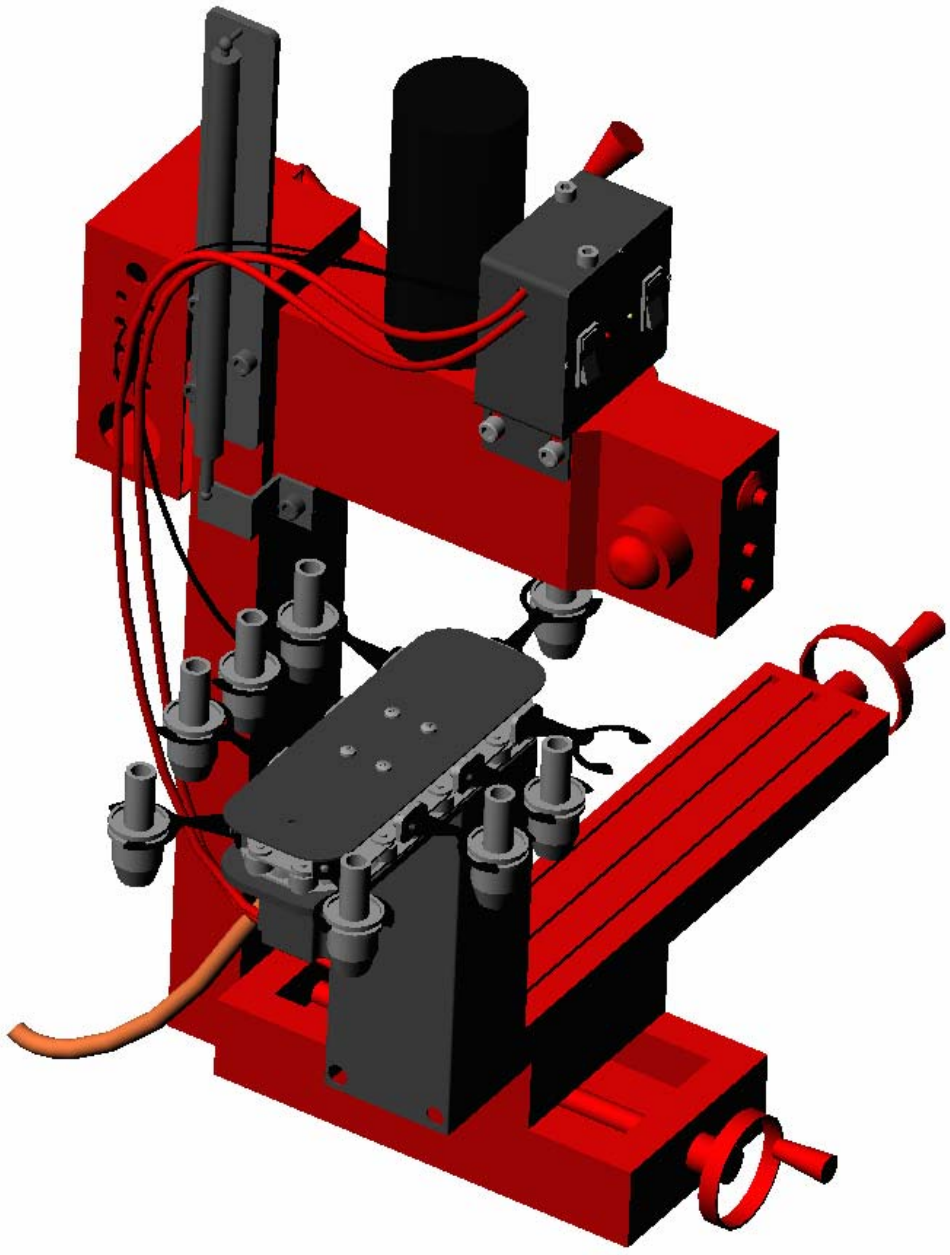
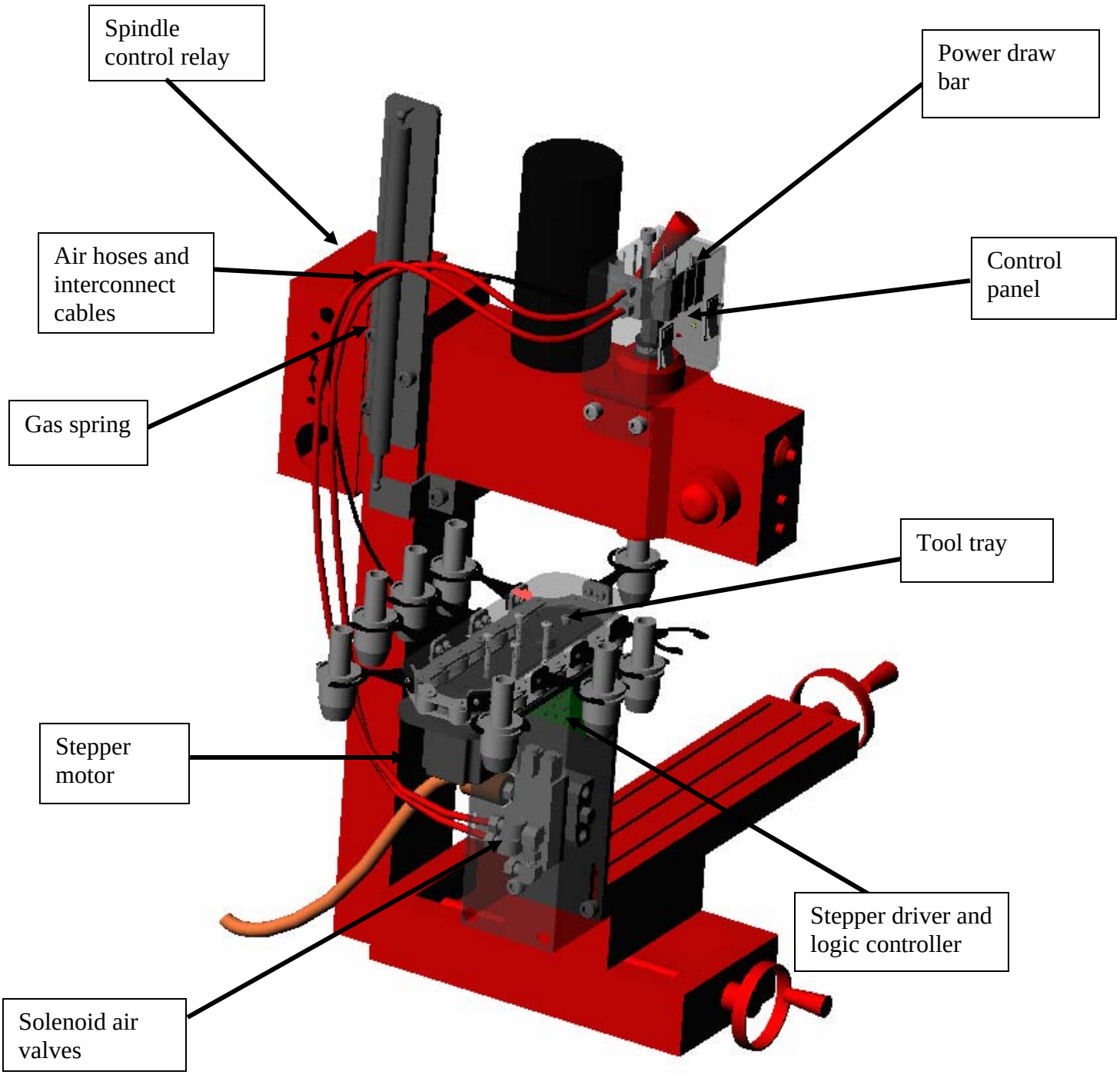
The Z-Bot Tool Changer



Principles of Operation
Revision 2.0

Overview

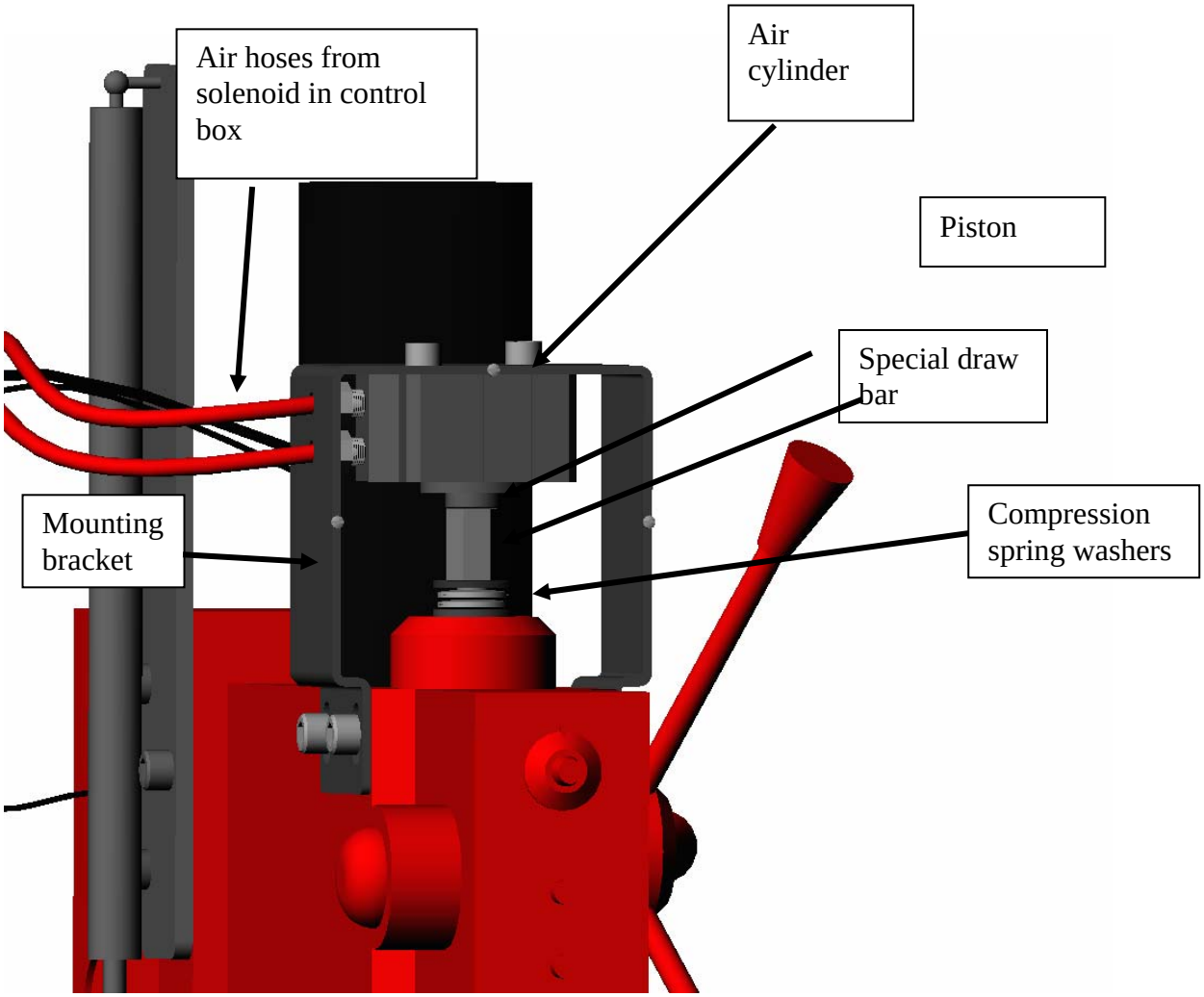
The Z-Bot Tool Changer is a complete, out of the box, solution for automated tool changing on all Sieg Mini-Mills. It is designed to work with the Tormach tool changing system for R8 or MT3 spindle inserts. The tool changer comes with all necessary components required to convert a parallel port (or equivalent) driven CNC mill to 100% automated operation.



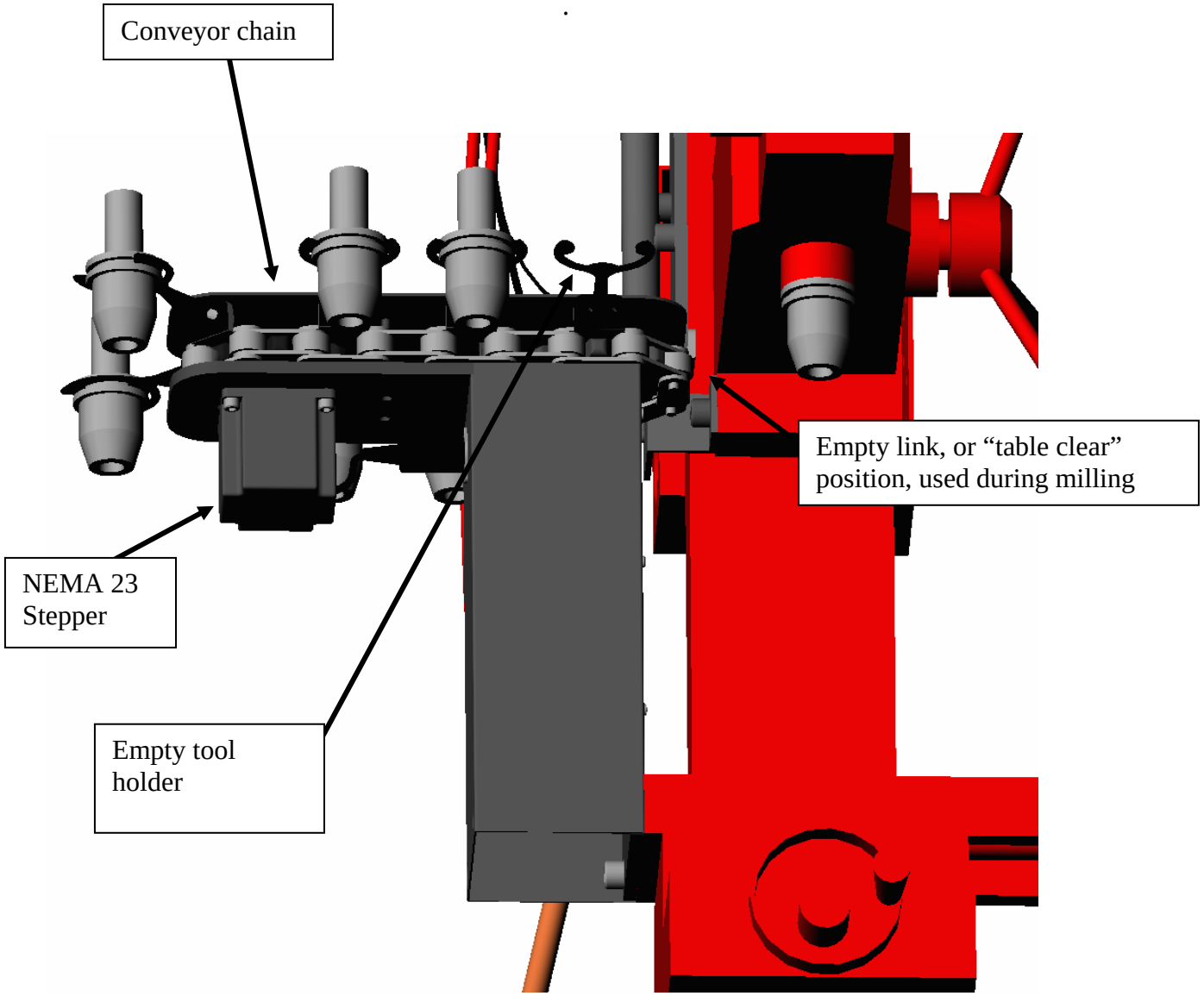
Component Description

1) Power Draw Bar – The purpose of the draw bar system is to push the Tormach collet down for tool removal/insertion, and conversely, to draw the collet tightly against the spindle to lock the tool for machining. A solenoid activated air cylinder drives the draw bar down and up between the draw bar nut and the top of the spindle assembly draws the bar up. To accommodate the compression spring washers, a special draw bar is used that abbreviates the top nut of the standard draw bar. When the air pressure to the cylinder is reversed, the piston retracts to clear the top nut of the draw bar for milling. The spring washers and thrust bearings turn with the spindle assembly during milling operations..

The draw bar mount permits the use of the stock gear driven spindle, or the popular belt drive add-on manufactured by Ron Steele and sold by LMS (see www.littlemachineshop.com).

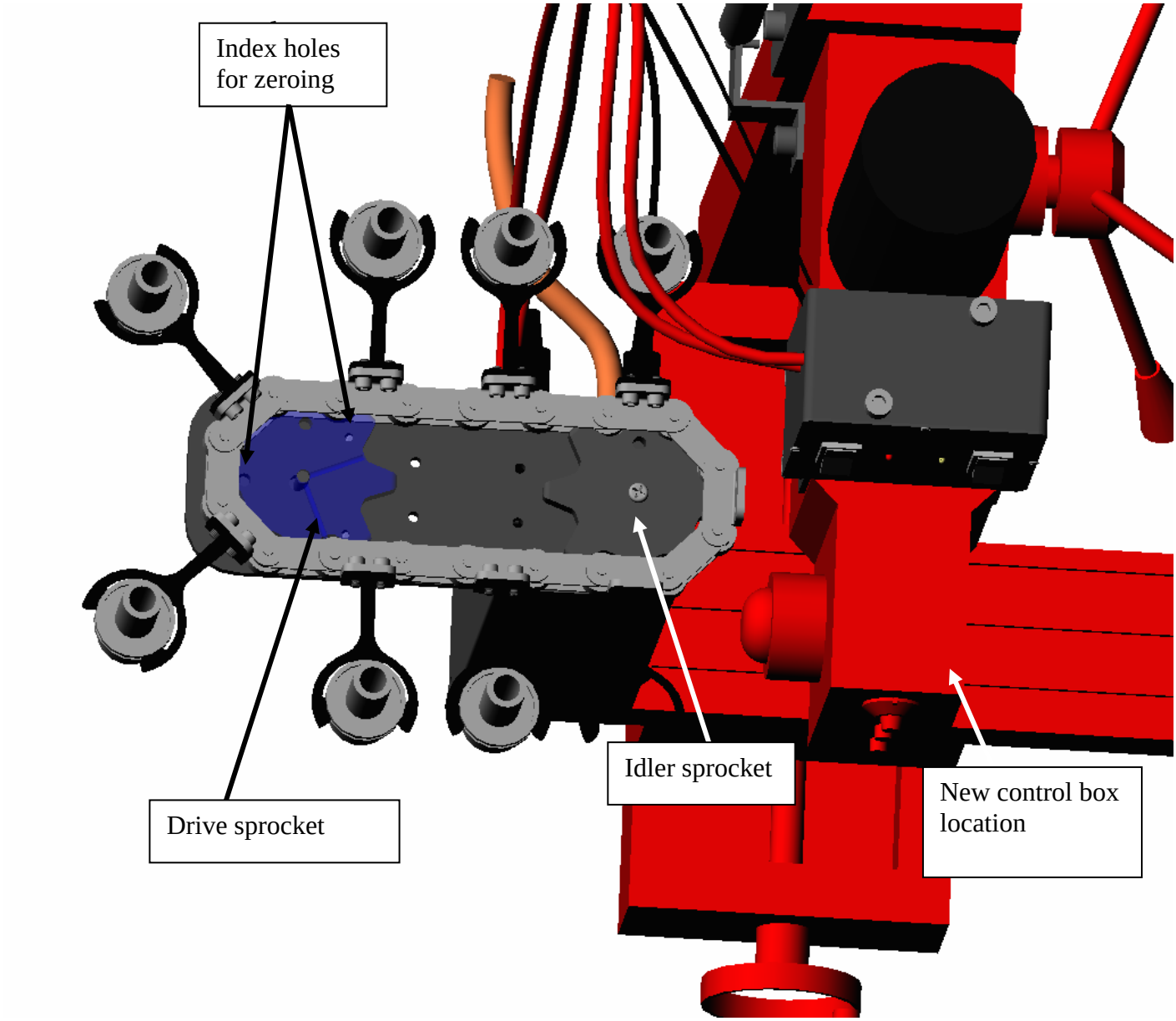


2) Tool Tray (patent pending)– The tool tray is a conveyor chain with tool holder arms affixed. The mechanism is mounted to a heavy sheet metal "L" bracket attached to the existing swarf gate screws on the mini mill table. The drive sprocket is powered by a supplied NEMA 23 stepper motor and driver. The inbound sprocket is an idler. The tool chain holds an even number of tools arms, plus one "clear" or empty position. The "clear" position provides a simple and cost effective way for the tool tray to remain clear of the machining table while the mill is cutting. When milling, the tool tray is rotated to present the empty chain link (no tool arm) to the spindle. In order to allow use of the entire milling table, the stock mill control box which contains the control knob, emergency stop switch, and indicator lights is moved to the front of the mill, thereby eliminating all interference with the tool tray when the mill head is lowered to any position. Tool trays for 8,12 and 16 tools are available.

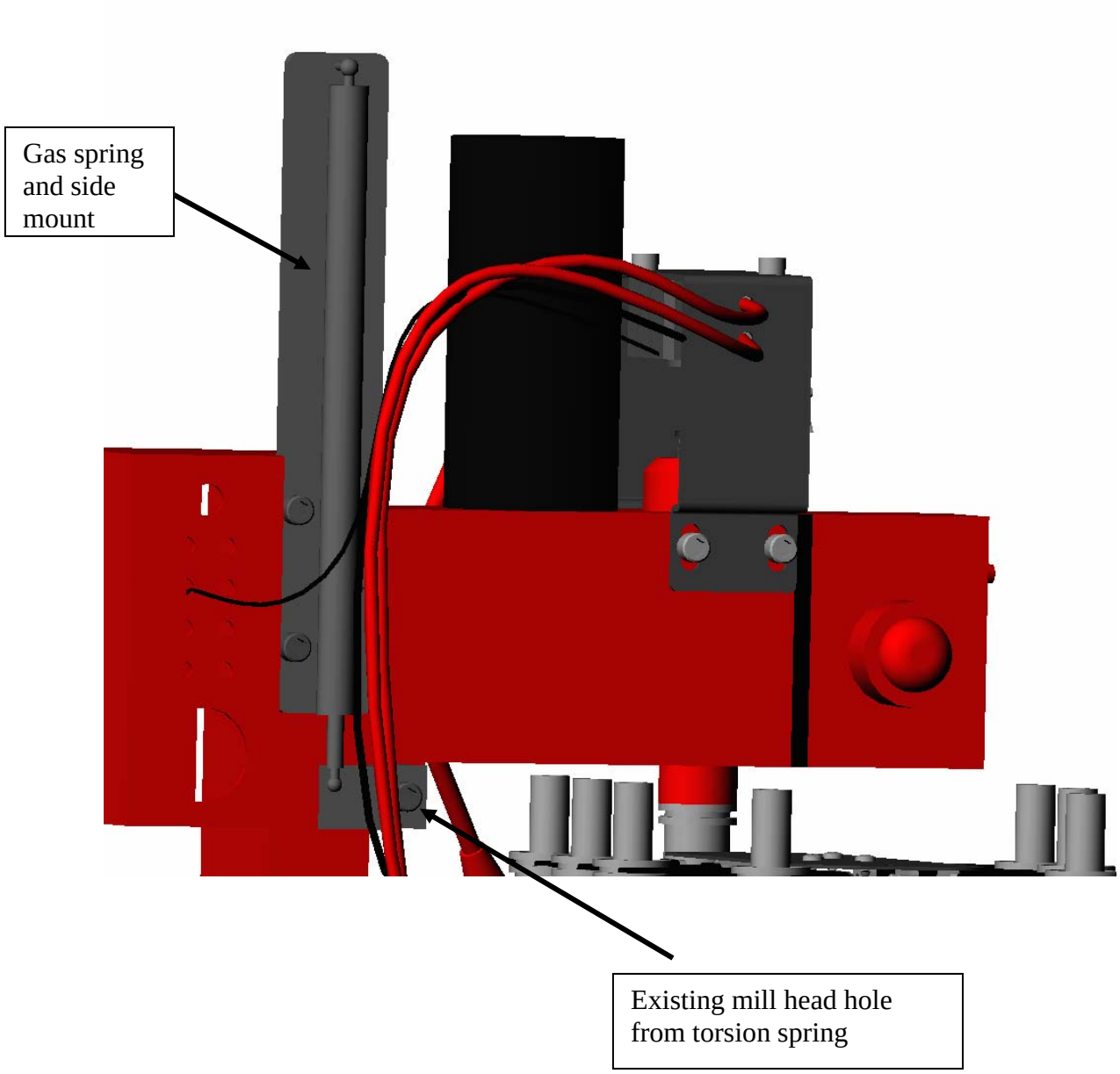


One additional tool arm may be attached in the “clear” position if full X axis is not required. Maximum adjacent tool diameter is 2.5” (large enough for JT1 ½” chuck and small boring head) . Larger tools, such as fly cutters, are made possible by keeping adjacent holders empty.

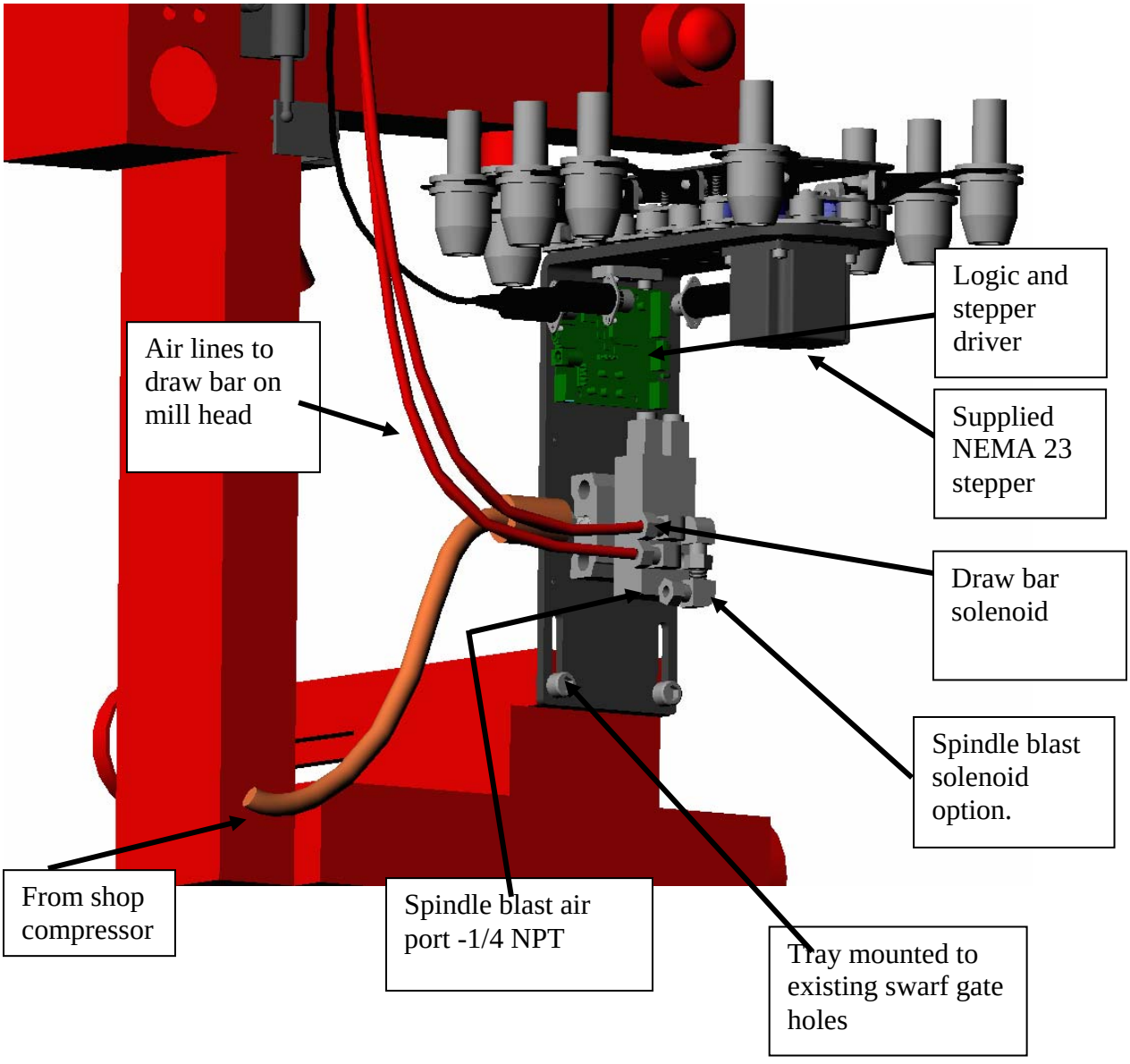
The tray is zeroed via an index hole in the sprocket , and an aligning hole in the tray base. A .25” drill rod inserted through the sprocket hole into the base hole aligns the tray with the clear position centered at the spindle.



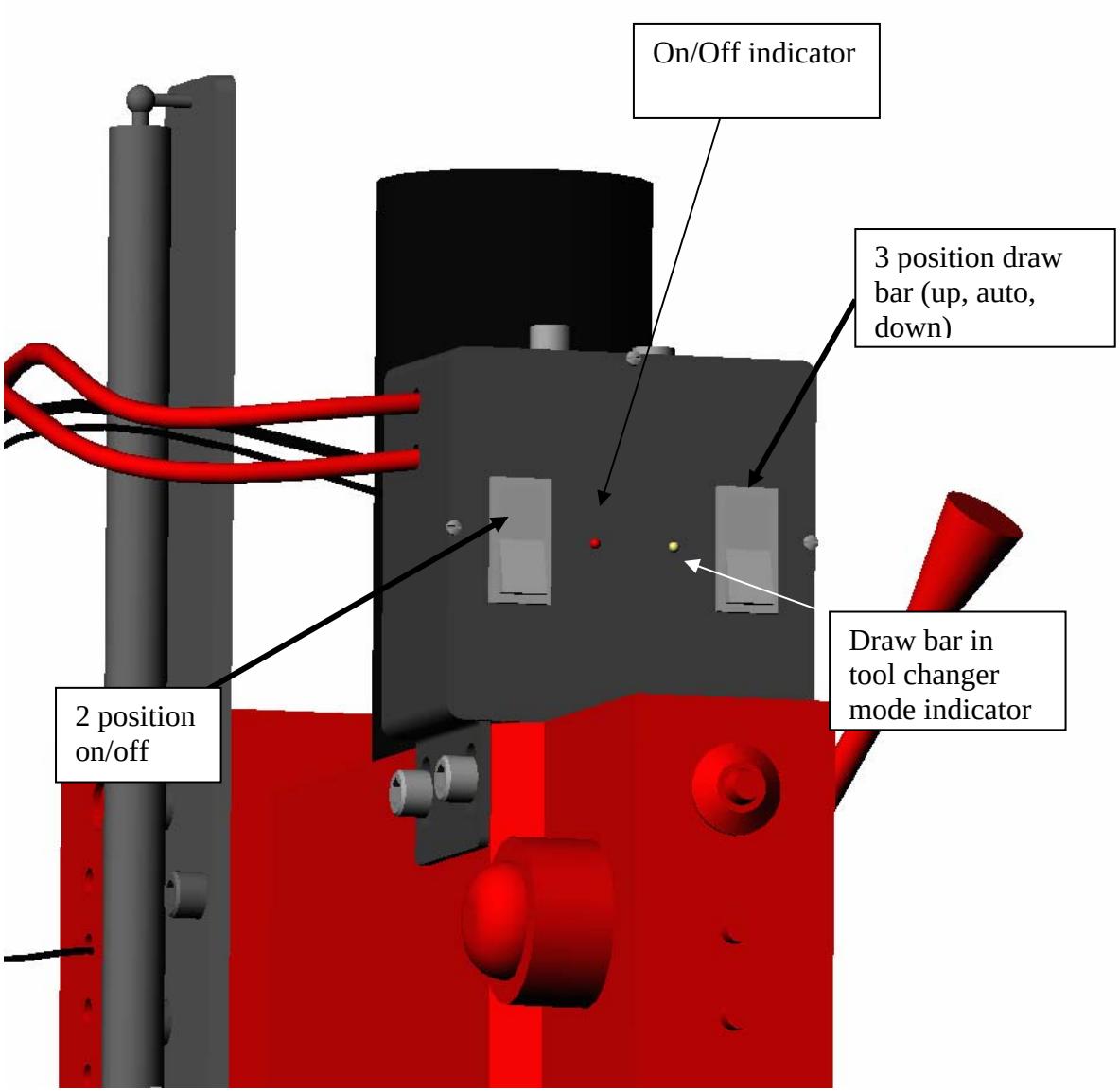
3) Gas spring – The mini-mill employs a torsion spring to counter balance the mill head. This interferes with the tool tray on the left side of the mill. A supplied gas spring replaces the stock torsion mechanism, (50 lbs force) and clears the way for the tool tray, permitting the mill head to cut unobstructed across the entire XYZ axis range of the mill.



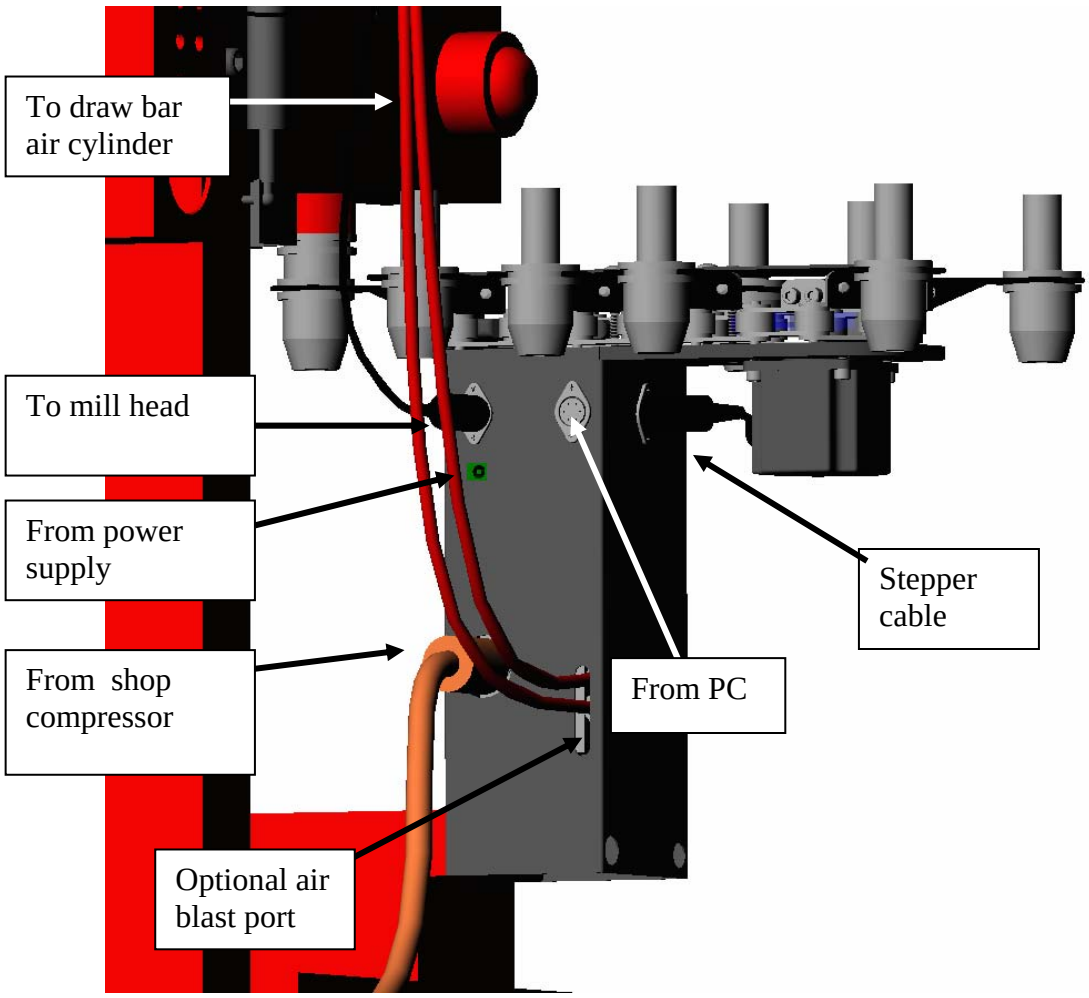
4) Electronics/controls package – The tool changer comes with a stepper motor/ driver to rotate the tool tray, solenoids/ air valves to work the pneumatic draw bar, pc interface connection, an easy to install modification for spindle control, and a 1.5 A/16.5V linear power supply**.** The spindle relay is inserted into the existing mill control box according to the supplied wiring diagram**.**. An optional solenoid/ air valve can be ordered to blow off the spindle prior to tool insertion.



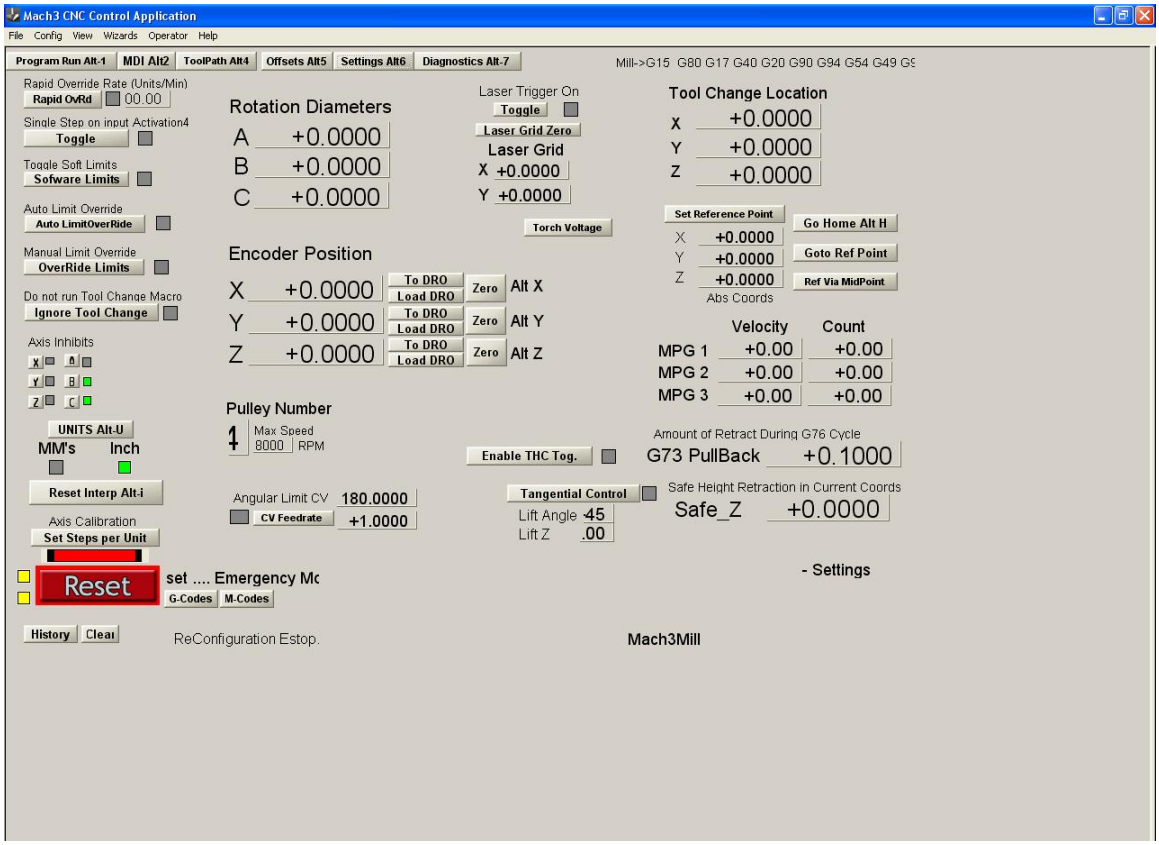
A control box mounted to the draw bar housing contains a 2 position main power switch on the left, and a 3 position draw bar switch on the right. The draw bar may be latched up or down manually with the switch. The center position is for automatic tool changer mode, when the draw bar is under part program control. Also included are indicator LEDs. The red LED glows when the main tool tray power is turned on. The yellow LED glows when the draw bar is running in tool changer mode.



A supplied six pin DIN connector with 6'wired leads intefaces the tool changer to the PC parallel port or breakout board (recommended). . The electronic package requires a minimum of 3 output pins, and as many as 5 output pins from the PC. Minimum configuration are pins for tray step, draw bar , and spindle control. Optionally a 4th pin, for air blasting the spindle, and a 5th pin for tray direction control may be added to minimize tool rotation time. A 6th pin on the DIN connector is for GND.



5) Software – Macros and instructions for configuring Mach3 (available from www.artofcnc.com) for automatic tool changing are supplied on a CD/ROM or may be downloaded from www.homecnccontrol.com. The code uses standard interfaces to rotate the tool tray (any angular axis – C is recommended) , jog all axis, fire the solenoid for the draw bar, stop and start the spindle motor(via standard M and G codes), or air blast cleaning ofthe spindle. Typically, the C axis (or other angular axis) is configured to step from tool to tool for each single degree or unit. Therefore turning the tool tray to Tool *n* is simply a G0 C*n* command. Tool 0, the empty slot is reached, via G0 C0 and so forth. Given supplied macros, the user is free to use G/M-code to rewrite or enhance the provided sequence. Straight forward basic functions make the system extremely customizable.



The following macros are supplied on the CD:

M6008.m1s	TOOLOUT complete sequence as below
M6009.m1s	TOOLIN complete sequence as below

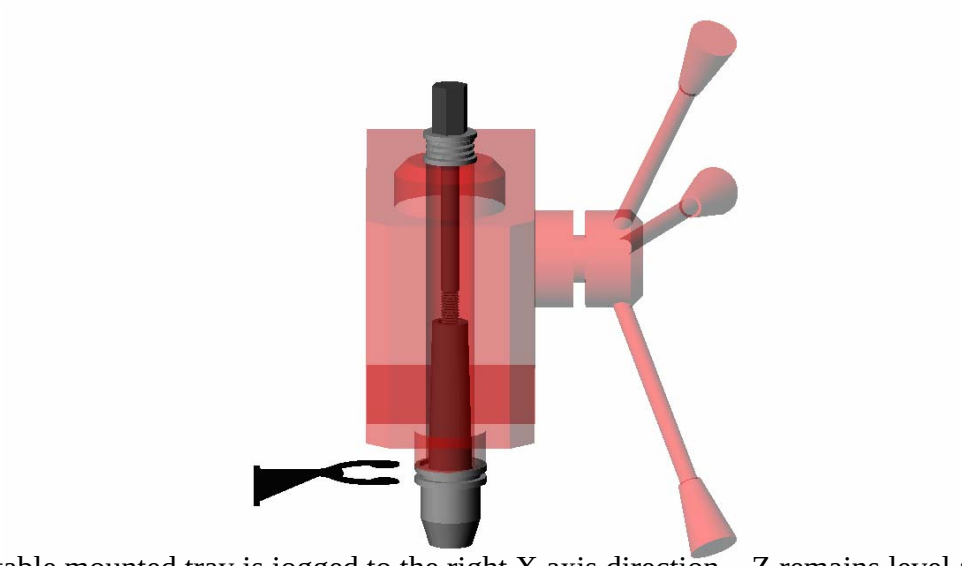
M6000.m1s	Draw bar disengage solenoid (collet up/closed)
M6001.m1s	Draw bar engage solenoid (collet down/open)
M6002.m1s	Blow off spindle only (optional component)

Tool Changing Method of Operation

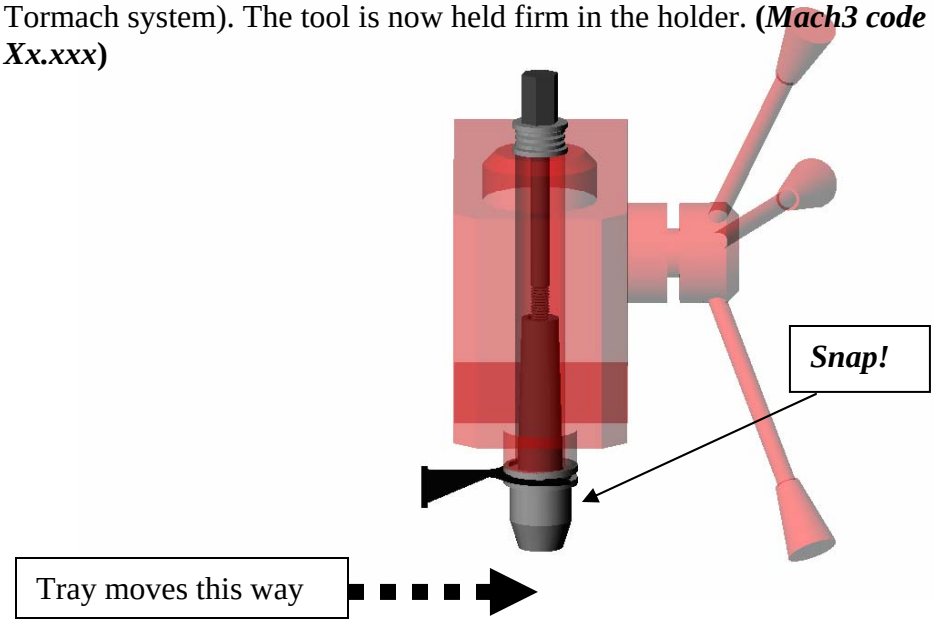
1) TOOL OUT ***(Use Mach3 macro M6008 for the complete sequence)***

1) The tool tray is turned to present the desired empty tool arm to the spindle **(*Mach3 code as : G0 Cn, where n is the empty tool tray location*)**

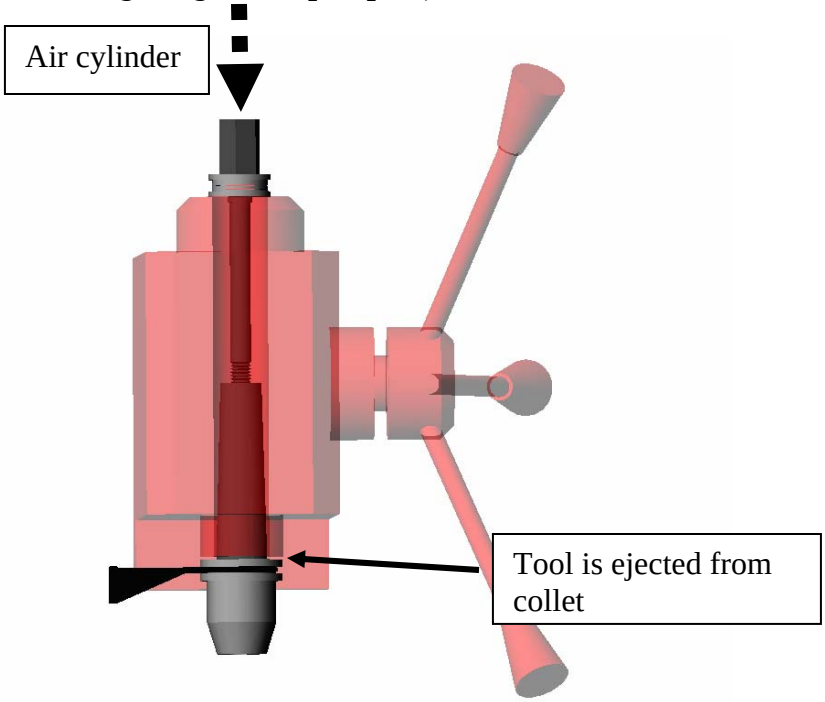
2) The spindle is stopped using relay inside speed control box. **(*Mach3 code as : M5*)**



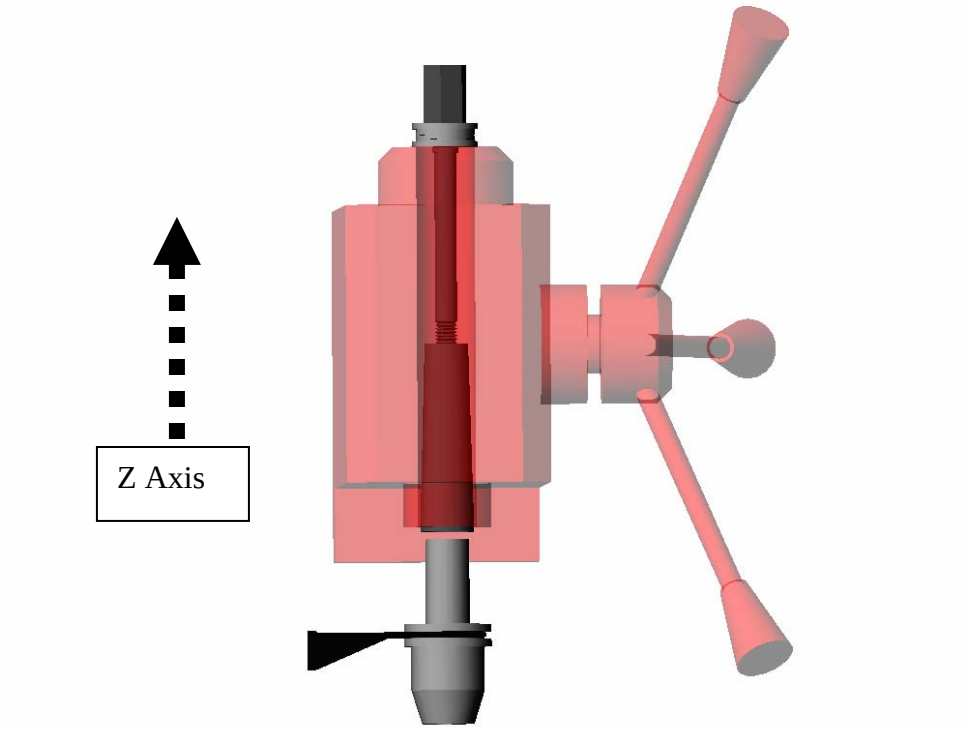
3) The table mounted tray is jogged to the right X axis direction – Z remains level at the proper height for engaging the spring clips on the tool arm. The arm engages the slot in the Tormach tool holder shoulder (this slot is a minor modification to the stock Tormach system). The tool is now held firm in the holder. **(*Mach3 code as : G0 Xx.xxx*)**



4) The draw bar solenoid is engaged, which lowers the collet enough to free the tool. This is typically no more than .1" The draw bar air cylinder will remain engaged until the tool is removed. **(*Mach3 code as : M6001 –macro file M6001.m1s on the CD which fires the solenoid using assigned output pins*)**



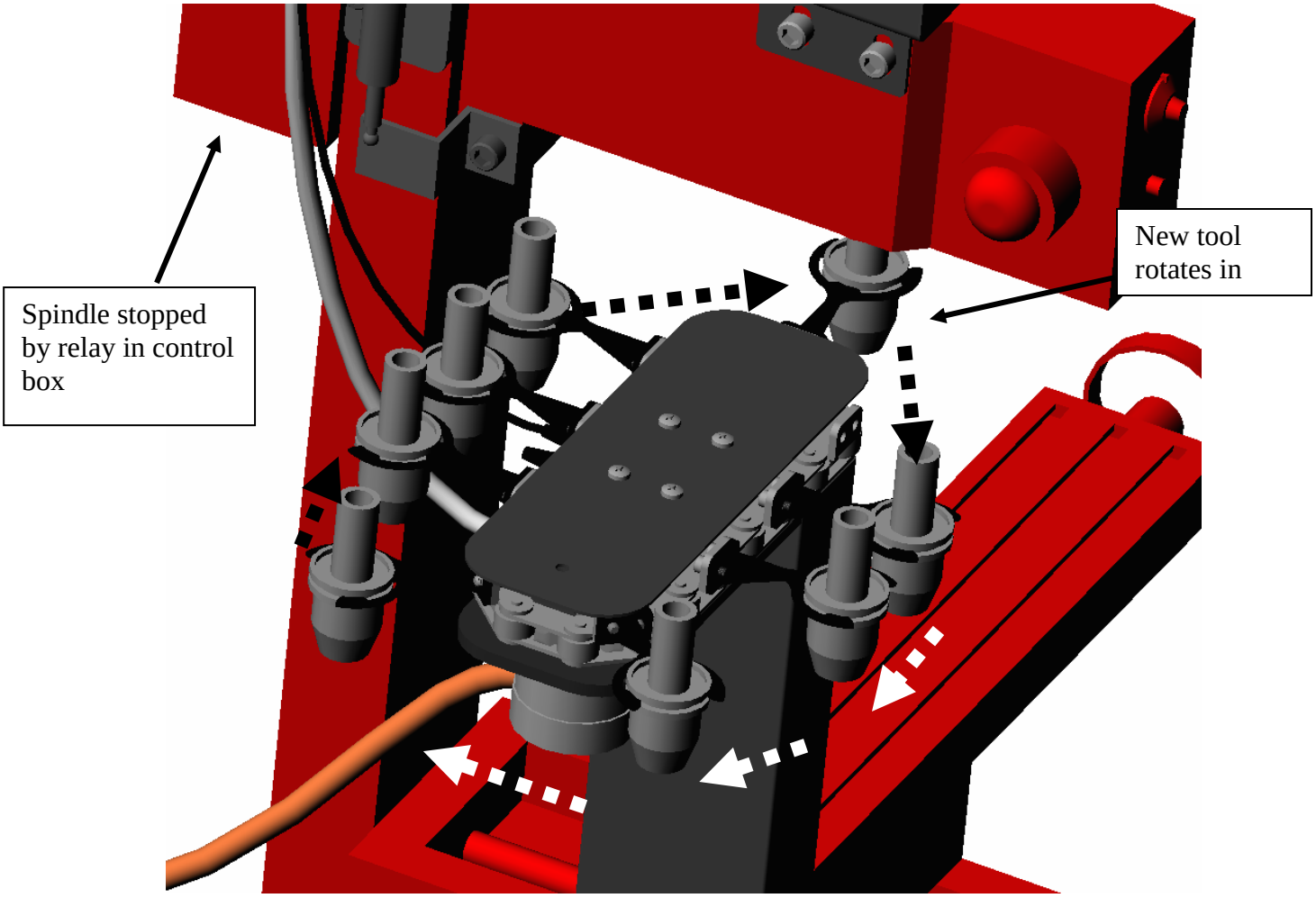
5) The Z axis rises, retaining the old tool in its tool holder arm. The available spindle is now hovering above the Tormach tool holder. We are now ready for a TOOL IN operation**. (*Mach3 code as : G0 Zz.zzz*)**



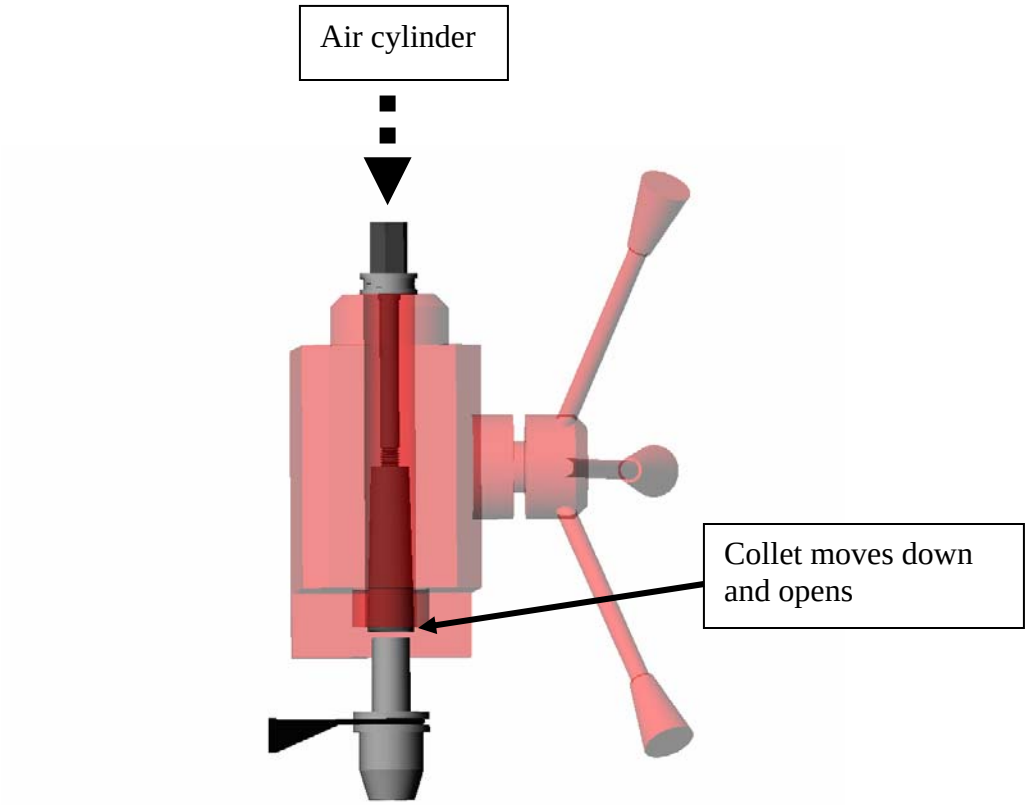
2) TOOL IN-*(Mach3 macro M6009 for the complete sequence)*

1) The spindle is stopped (*Mach3 code as : M5*)

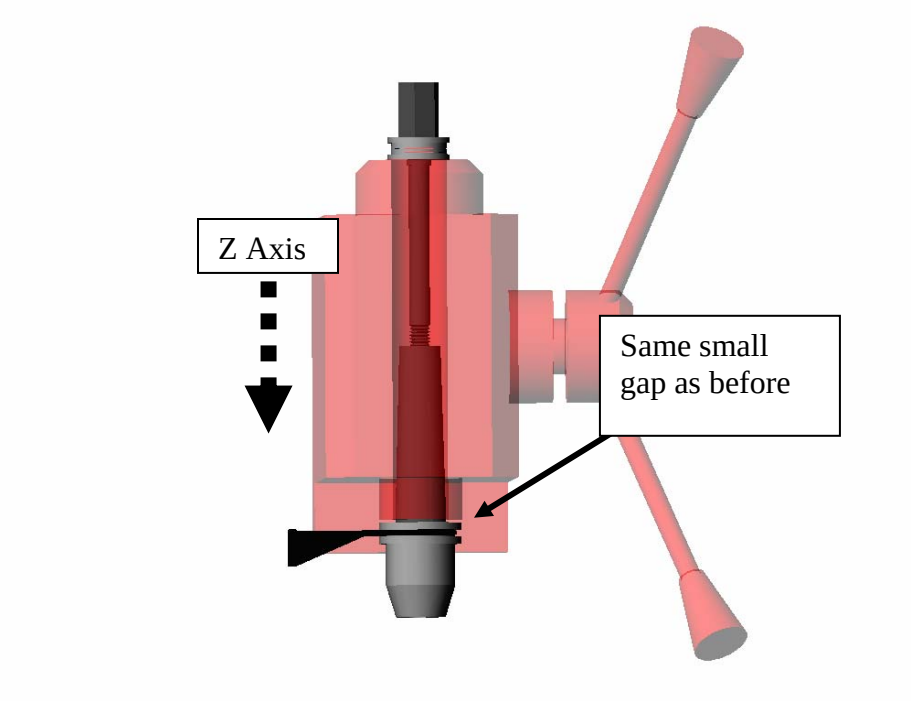
2) The tool tray is rotated to present the desired new tool to the spindle. **(*Mach3 code as : G0 Ct, where t is the new tool tray number desired*)**



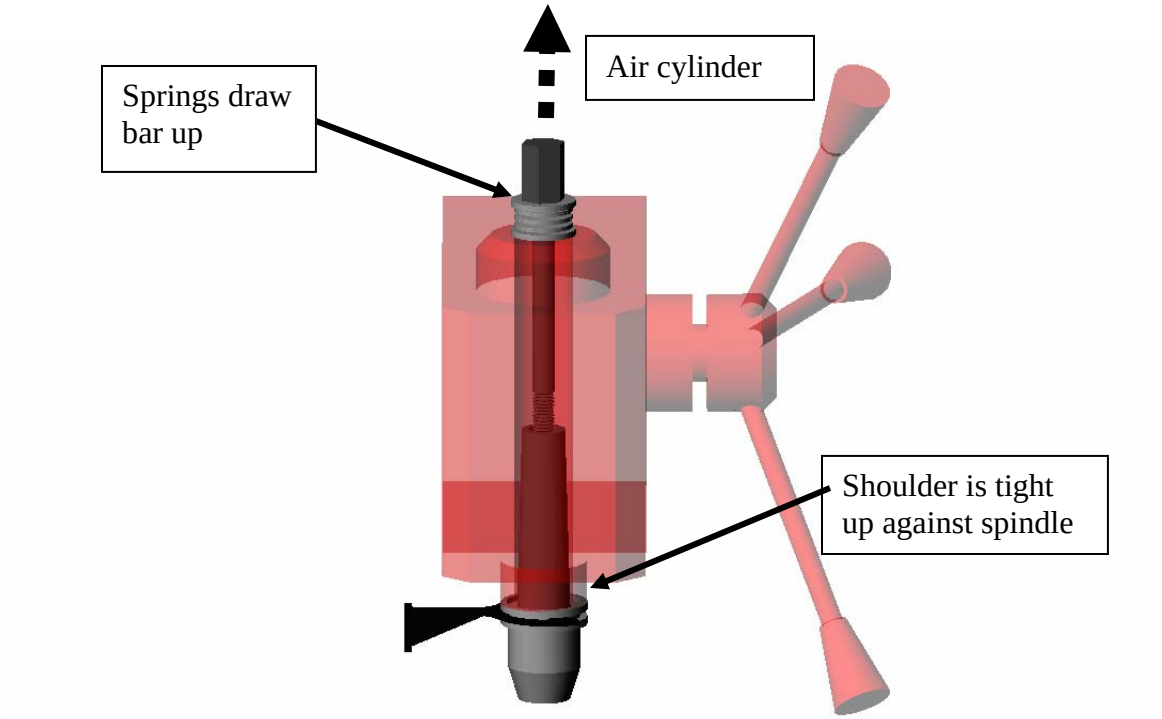
3) The solenoid is engaged as above, forcing the empty collet down and open (just in case a TOOLOUT operation didn't immediately precede this). **(*Mach3 code as : M6001*)**



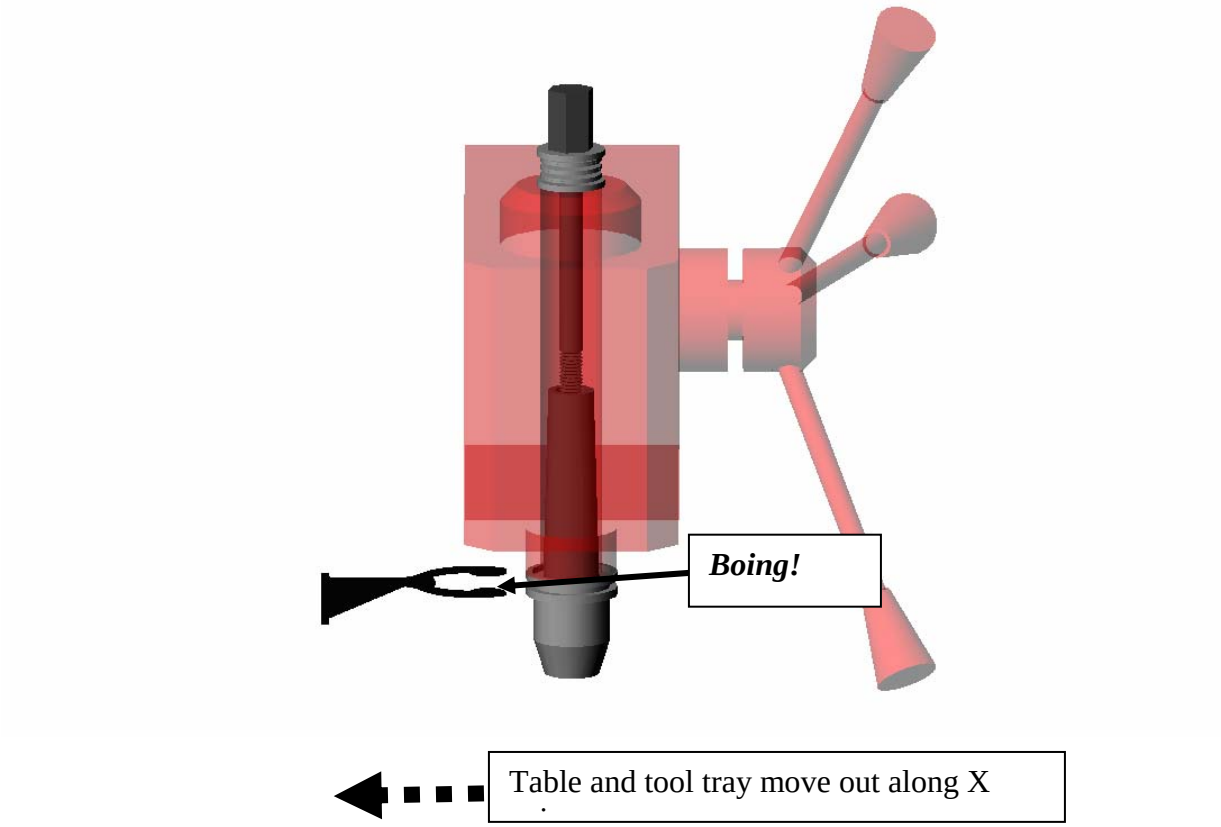
4) The Z axis is moved down onto the Tormach tool holder sliding the straight ¾" shank of the Tormach holder into the open collet until the Tormach holder shoulder is bottomed against, or a very small distance away from, the spindle **(*Mach3 code as : G0 Zz.zzz*).**



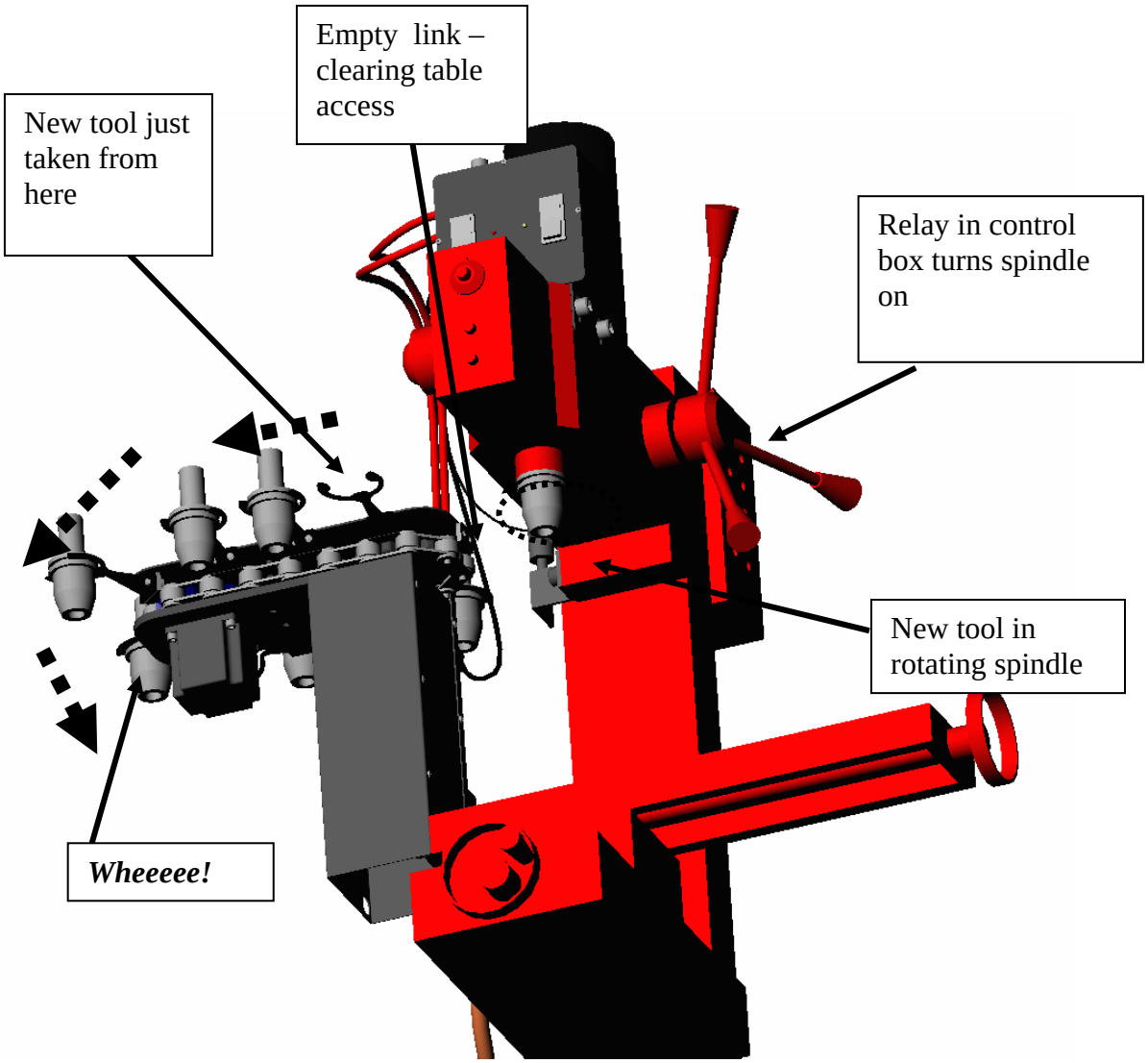
5) The draw bar solenoid is disengaged. The spring washers draw the bar up and the tool holder is drawn tight up into and against the spindle. **(*Mach3 code as : M6000 – supplied macro file M6000.m1s on the CD*)**



6) The table is moved in the X direction to release the tool out of the holder clips – **(*Mach3 code as : G0 X -x.xxx*)**



7) The tool tray is rotated to present the empty chain link to the spindle – leaving the entire table clear for machining. **(*Mach3 code as : G0 C0*)**



8) Spindle is turned on again. **(*Mach3 code as : M3*).**

9) Turn on cutter length compensation for the new tool **(*Mach3 code as : G43 Ht, where t is the tool table offset for the new tool).*** Remember that the tool offset may be different from the tray location, as when tool #73 is in tray location 1, for example. In this case the tool is picked from tray location 1, *GO C1,* but length compensation is *G43 H73*.

HAPPY MILLING!